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Locational Preference of Last Mile Delivery Centres: A Case Study of Thailand Parcel Delivery Industry

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Abstract

Purpose – The purpose of this paper is to improve last mile delivery capability and ensure customers' satisfaction by approaching an analytic hierarchy process(AHP) and identifying criteria framework to determine locations of last mile delivery centre(LMDC).

Research design, data, and methodology – Traffic congestion and emission policy in cities are barriers of last mile delivery in dense areas. The urban consolidation centre(UCC) cannot increase last mile delivery efficiency in dense cities because of their space and traffic limitation. In this paper, we develop a case to improve last mile delivery efficiency and to ensure customers' satisfaction by concentrating on LMDC. In addition, AHP has been applied to identify criteria framework and determine LMDC locations. The weighted priorities are derived from parcel delivery industry experts and have been calculated using Expert Choice software.

Results – The framework criteria have assisted decision makers to place LMDC in a dense area to enhance customer's satisfaction with last mile delivery service.

Conclusions – AHP has provided ranking framework criteria of LMDC potential for parcel delivery industry. The LMDC helps by improving last mile delivery efficiency to final destination amids conditions of CO_2 emissions, traffic congestion, and pollution problems. It especially concerns delivery service activities when delivering parcels to customers rather than UCC.

Keywords: Urban Consolidation Centre, Last Mile Delivery Centre, Last Mile Delivery, Decision Making.

JEL Classifications: L9, L91, R41, R53.

1. Introduction

A phenomenon of city expansion has increased globally—cities become "megacities" when a substantial number of people immigrate from rural to urban areas within a limited city area(Myers, 2016). This situation has been explored worldwide and several governments have become concerned about balancing population density. Moreover, cities plan to develop locations and allocations in other areas to protect a population's concentration. Many people prefer to live in a city versus a rural area because cities offer the chance for employment and a higher quality of life. Further, the impacts of environmental and pollution issues have increased in cities, including air and noise pollution, traffic congestion, and CO_2 emissions. Cities currently emphasize pollution controls, and especially those pertaining to air pollution and congestion.

The parcel delivery industry involves the delivery of freight to a final destination, typically a dense area, but problematic delays in pollution policy have motivated governments to eliminate vehicle traffic from cities. An urban logistics infrastructure would help to mitigate traffic congestion and pollution problems in dense cities.

1.1. Urban consolidation centre

UN-Habitat(2015) considered the topic of the environment and society in the transportation sector, as this has grown every year since 1980. Last mile delivery plays an important role in the urban supply chain activity, such as when the last delivery process moves goods and supports a last transit node to the end destination. Although last mile delivery primarily involves sending parcels to customers, it is limited by its freight routing and a city's congestion, and it cannot make a full shipment in one truckload. Nathanail, Gogas and Adamos(2016) indicate that a supply chain's last

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mile delivery process is often less efficient, including customer package failures and inefficient logistics.

The urban consolidation centre(UCC) is a significant asset in supporting customer demand in a last mile chain, and some studies have applied cities' consolidation centres to reduce the number of vehicles, congestion, and CO_2 emissions in residential areas(Van Rooijen & Quak, 2010). A city consolidation centre concept involves splitting a city's distribution activities from inside and outside the city. Some countries have also applied UCCs in cities(Van Rooijen & Quak, 2010). Monaco has implemented a consolidation center.

Monaco's government supported substantial subsidies and provided electric vehicles inside the city, but this project did not succeed due to the electric vehicles' power capacity not being suitable for UCC, which impacted increasing traffic congestion. For example, an electric vehicle slows all traffic, and some regulations did not receive sufficient support. Moreover, some UCC locations were not suitable to support customer service because they were far from city center. However, most studies have applied UCCs in order to improve economic flow and first freight efficiency when delivering an order. For example, the UCC is a consolidation centre that receives goods from a primary mode of transport, such as rail, sea, or air. All products are transported to the UCC before delivery to the end destination by last mile delivery. Moreover, the UCC is always located just outside the city or on its border, with easy access to facilities from highways, close proximity to destinations, requiring a large amount of space, and is difficult to construct inside dense areas.

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Moreover, some UCC locations were not suitable to support customer service because they were far from city center. However, most studies have applied UCCs in order to improve economic flow and first freight efficiency when delivering an order. For example, the UCC is a consolidation centre that receives goods from a primary mode of transport, such as rail, sea, or air. All products are transported to the UCC before delivery to the end destination by last mile delivery. Moreover, the UCC is always located just outside the city or on its border, with easy access to facilities from highways, close proximity to destinations, requiring a large amount of space, and is difficult to construct inside dense areas.

The idea of this paper is to support the importance of placing the focus of location preference framework on using last mile delivery centres(LMDCs) to fulfil the short distances of last mile deliveries, which will increase last freight efficiency and reduce the impact of traffic congestion in urban areas.

The remainder of this paper is organized as follows. First, we describe the importance of LMDCs, then propose the AHP methodology, review criteria for consolidation centres then explain how we develop the criteria framework. The last section contains a case study in Bangkok, Thailand, and results from the analysis.

1.2. The importance of last mile delivery centre

Online shopping has changed the retail industry dramatically and it is now important to provide quality services both in online and offline channels(Hwang & Lee, 2011; Lee & Feng, 2015; Lee, 2017; Kim, 2017; Choi & Yang, 2018). Online shopping and the associated innovative services have been improved quickly in Asian market, where the traditional offline retail infrastructure has not been well established even with the impressive recent online market growths(Su & Youn, 2011; Prashar, Verma, Parsad, & Sai Vijay, 2015; Phuong & Dat, 2017; Rahman, Ismail, Albaity, & Isa, 2017). In this respect, Olsen, Gergele, Ghee Chua, and Bartolucci(2015) posited that online shopping orders play a more important role in present-day delivery services. The parcel delivery industry has been concerned with strategies for one-day deliveries to customers by avoiding a city's traffic congestion, and have applied multiple devices to improve their services, such as through human delivery couriers and parcel lockers. European countries have focused on last mile delivery and motivating stakeholders concerned with last mile solutions by creating projects in Belgium, France, Netherlands, and the United Kingdom (Kayikci, 2010).

Urban freight movement provides a necessary element for transportation activities, multiple commodities flow, and city supply chain flows by delivering goods to a last node/end customer(Anand, Quak, Duin, & Tavasszy, 2012). This can decrease freight costs while solving environmental and social problems by depending on each country's individual characteristics(Taniguchi, Thompson, Yamada, Duin, & Oxford, 2001; Tadić, Tadić, Zečević, & Krstić, 2014). For example, the United Kingdom applied a consolidation centre in its London boroughs by cooperating with DHL to deliver parcels to its customers in September 2015. This achievement reduced vehicle trips by 57 percent, decreased kilometres traveled by 69 percent, and lessened the number of empty vehicles in operation by 72 percent, as well as reducing their CO_2 emissions(Mackean, 2015). Furthermore, UPS, DHL, Amazon, and Google invented devices to support last mile delivery, which eliminated traffic problems in dense areas and improved customer satisfaction.

Leesa-Nguansuk(2016) studied last mile delivery information to find that various optional tools can dispatch a parcel to the end customer, such as drones, robots, and electric vehicles. For instance, DHL applied a drone service in September 2014 to deliver life-saving medicines. Google has tested a drone to deliver packages to customers in less than 30 minutes. Moreover, Amazon has developed a drone as part of an environmentally friendly project. Robotics is another option to address this last mile delivery process. The last mile delivery market has rapidly expanded to include the same-day delivery market. Singh(2014) and Choi and Lee(2012) analysed online shopping mechanisms and showed that customer prefers supply networks which are closely localized to support a good delivery service.

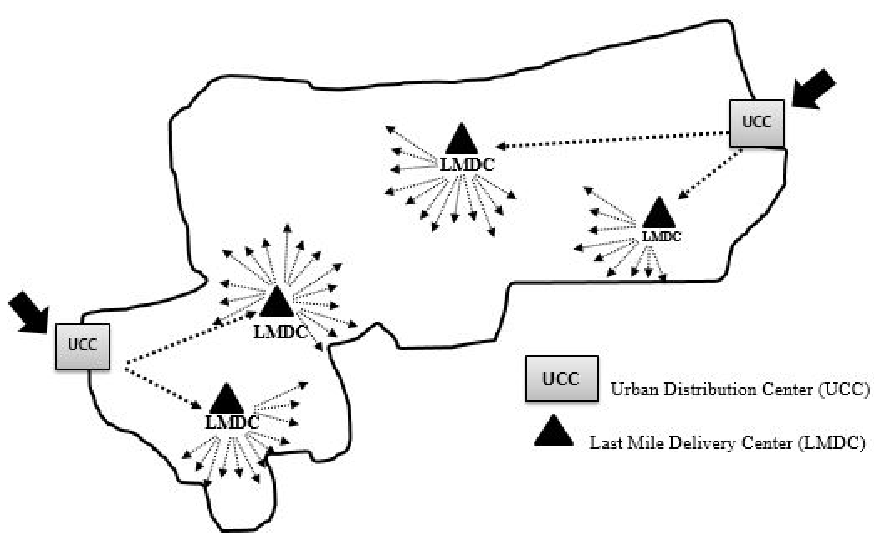
Although stakeholders are motivated by new technologies to support last mile delivery, they are faced with limitations for improving the efficiency of last mile because new technologies provide last mile services covering a short radius and still struggle with city environmental condition, such as traffic congestion in cities. Another way to increase last mile delivery efficiency is to involve an LMDC to support deliveries. The LMDC is a benefit to the parcel delivery industry, in that it generates customer satisfaction by managing and developing services to address the loading of goods, break-bulk parcels, routing limitations, and power charge centres.

1.2.1. Characteristics of Last Mile Delivery Centres

An LMDC is typically located inside a city and close to a densely populated area. It can ensure a flexible speed of service when demand and time are uncertain and address concerns regarding CO_2 emissions and congestion in dense areas. While these are smaller than UCCs <Figure 1>, LMDCs are not created to replace a UCC, but rather to support the UCC and improve the efficiency of last mile delivery. Furthermore, studies have noted that the type of vehicle necessary for last mile delivery was limited in its power supply, which decreased the capability to deliver through long-distance travel. The LMDC becomes a valuable alternative for solving distance limitations and increasing last mile freight efficiency in dense areas. Arvidsson and Pazirandeh(2017) are also focusing on other types of operational changes as sustainable alternatives, such as mobile depots in cities. Moreover, an LMDC is smaller than a UCC and can not only provide a diverse method of transportation in a dense area, but can also be located in a specific area of density, as <Figure 1> illustrates.

2. Criteria Framework

This study reviews three consolidation concepts: the city logistics centre, logistics consolidation centre, and relief consolidation. Consequently, we can gain specific ideas from these topics that may be applied to LMDCs. For instance, a relief consolidation centre can dispense medicines or aid to dense areas under uncertain conditions when disasters occur. Several studies(Yang & Lee, 1997; Chen-Tung, 2001; Birgün & Güngör, 2013; Elevli, 2014; Tomić, 2014; Zak & Węgliński, 2014; Mahmud, Rayhan, & Ahamed, 2016) pioneered the location selection problem, as multiple criteria decision-making was applied to select the locations of distribution centres and other logistics facilities. The analytic hierarchy process(AHP) is a methodology applied in multi-criterion selection problems and involves pairwise tools to help decision-makers select a proper location for new facilities.



<Figure 1> Different identifications of UCCs and LMDCs

2.1. City Logistics Centres

In the city logistics reviewed, developed countries have been prioritized in the transportation sector; therefore, pollution and traffic congestion are mentioned by applying a multi-criterion, multi-decision methodology to analyse which criterion is helpful to reduce a city's CO_2 emissions and congestion. For instance, Taniguchi et al.(2001) implemented an AHP to select a solution to improve quality of life through three criteria: the improvement of freight and passenger movement, reduction of CO_2 emissions, and reduction of noise in the city. Awasthi and Chauhan(2011) integrated two methodologies - AHP and fuzzy TOPSIS—by applying four technical, social, economic, and environmental criteria to choose a proper solution for city planning logistics. Tadić et al.(2014) combined fuzzy DEMATEL, fuzzy analytical network process(ANP), and fuzzy VIKOR methods in their city logistics concept to choose a proper methodology when faced with different stakeholders' participation. The primary criteria in CL are economic, environmental and natural, and social.

2.2. Logistics Centres

The logistics centre concept was added in CL to reduce a city's number of vehicles. For example, Kayikci(2010) applied fuzzy AHP and artificial neural network methods to selected city logistics centers. Chen-Tung(2001) determined candidate locations by an approaching fuzzy logic method. Yang and Lee(1997) used AHP to evaluate alternate site locations. Kuo(2011) used fuzzy DEMATEL and AHP/ANP methods to determine optimal construct weights of all criteria for an international distribution centre from an environmental perspective. Badri(1999) combined AHP and goal programming to make relocation decisions to support global facility planning. Awasthi, Chauhan, and Goyal(2011) applied a fuzzy TOPSIS method to evaluate and select the best location to place UCCs by minimizing traffic congestion and goods movement in urban areas. Some studies note the multi-criteria decision making approach as applied to last mile deliveries; For example, Wang, Jung, Yeo, and Cho (2014) studied how to choose last mile delivery modes for e-fulfillment by attended home delivery, reception box, and collection-and-delivery points in different scenarios. Nathanail et al.(2016) applied both AHP and key performance indicators to assess urban freight terminals' contributions in last-mile operations.

2.3. Relief Logistics Consolidation Centres

The relief consolidation centre includes a similar rapid response concept. Furthermore, selecting disaster centre locations is necessary for a quick-response concept to mitigate patients, such as applying a fuzzy AHP to select locations for logistics disaster centres to aid disaster victims when an earthquake occurs(Tuğba Turğut, Taş, Herekoğlu, Tozan, & Vayvay, 2011). Bouhana, Chabchoub, Abed, and Fekih(2013), and Awasthi et al.(2011) applied an AHP methodology in a facility location selection scenario, but neither applied AHP in an LMDC to support last mile delivery in a developing country.

3. The Proposed AHP Methodology

3.1. AHP methodology

Companies are often concerned with the way of selecting the right project for their business. As a result, factor conditions become major priorities for companies. There are a number of methods that can be used to help the decision maker evaluate and select a project. Each of these methods has its strengths and weakness, and some are strictly qualitative rather than quantitative(Paleie & Lalic, 2009). The AHP is applied by many authors, for example, Al-Harbi (2001) applied AHP in project management to list contractors and select the best contractors for the project. Subramanian and Ramanathan(2012) reviewed the application of AHP in operation management as a major tool for formulating and analysing decisions. Therefore, AHP is a decision-making method that supports the qualifying relationship of pairwise criteria on the intuitive determination of the decision maker, as well as the consistency of the comparison of alternatives in the decision-making process (Saaty, 2008).

<Table 1> AHP steps for LMDC framework criteria

AHP steps	For Location Preference(LMDC)
Step 1: Structuring of the decision-making problem.	To find the criteria framework for placing LMDCs in a dense area.
Step 2: Making pairwise comparisons and obtaining the judgmental matrix.	Finding criteria for previous paper and interviewing criteria from experts, then making pairwise comparisons.
Step 3: Computing local weights and consistency of comparisons.	Computing local weight and consistency of comparisons by Expert Choice software.
Step 4: Aggregation of local weights.	Final weight of criteria framework for placing LMDCs.

The AHP is a tool to help decision-makers choose a proper solution in multiple criteria decision-making scenarios. This method compares pairwise factors and creates efficiency in decision-making problems by analysing complex situations and recommending a decision. Since AHP tools adapt to the behaviour of decision-making and are based on the knowledge and experience of the decision maker. Therefore, we still focus on AHP because the strength of AHP is that it is a flexible method and it is suitable to apply it to a specific project alongside the experience and knowledge of the decision maker. A process of applying

AHP to a decision-making problem involves four steps (Zahedi, 1986). Therefore, this paper will follow these steps to analyse the criteria of location preference and these will be applied in a case study of Bangkok, as <Table 1> illustrates.

<Table 2> illustrates the linguistic terms related to the pairwise criteria. Regarding linguistics term numbers, the decision-maker states numbers for pairwise criteria; for example, if the decision-maker states "Criterion A(CA) is of strong importance than Criterion B(CB)," this assumes a value of 5 on the scale. Alternatively, a comparison of CB to CA will score as(1/5) on the scale in the criteria's pairwise contribution matrix.

<Table 2> Linguistic scales of importance

Linguistic Scale of Importance	Value Scale
Equal importance	1
Low importance	3
Strong importance	5
Very strong importance	7
Absolute / extreme importance	9
Intermediate values between two adjacent judgments	2, 6, 4, 8

3.2. An AHP location decision model

Using collected criteria data, we are able to give an explanation of why these factors are important and included in our research, show in <Table 3>.

Saaty(2008) defined a process to generate priorities that follows the below steps:

1) Define the problem and determine the types of knowledge sought.
2) Start from the top of the decision hierarchy structure (goal), then determine the objectives.
3) Compare a set of pairwise matrices.
4) Use a pairwise comparison to weigh the scores regarding which criteria are important.

3.3. Data Collection and Analysis

As in these four steps, we previously explained the importance of LMDCs as support centres for UCCs and customers to improve the efficiency of last mile delivery. However, the problem of this study is identifying the proper location for the LMDC in cities, and as such, we created the decision hierarchy structure in <Figure 2>. This illustrates that framework criteria for placing LMDCs in dense cities is the objective. Moreover, experts compared a set of pairwise criteria matrices and the Expert Choice software weighted the scores regarding which criteria are important for locating LMDCs, seen in <Table 4>. The AHP measures the overall consistency of judgments by means of consistency ratio(CR) and the value of the CR should be 10 percent.

<Table 3> Description of these factors

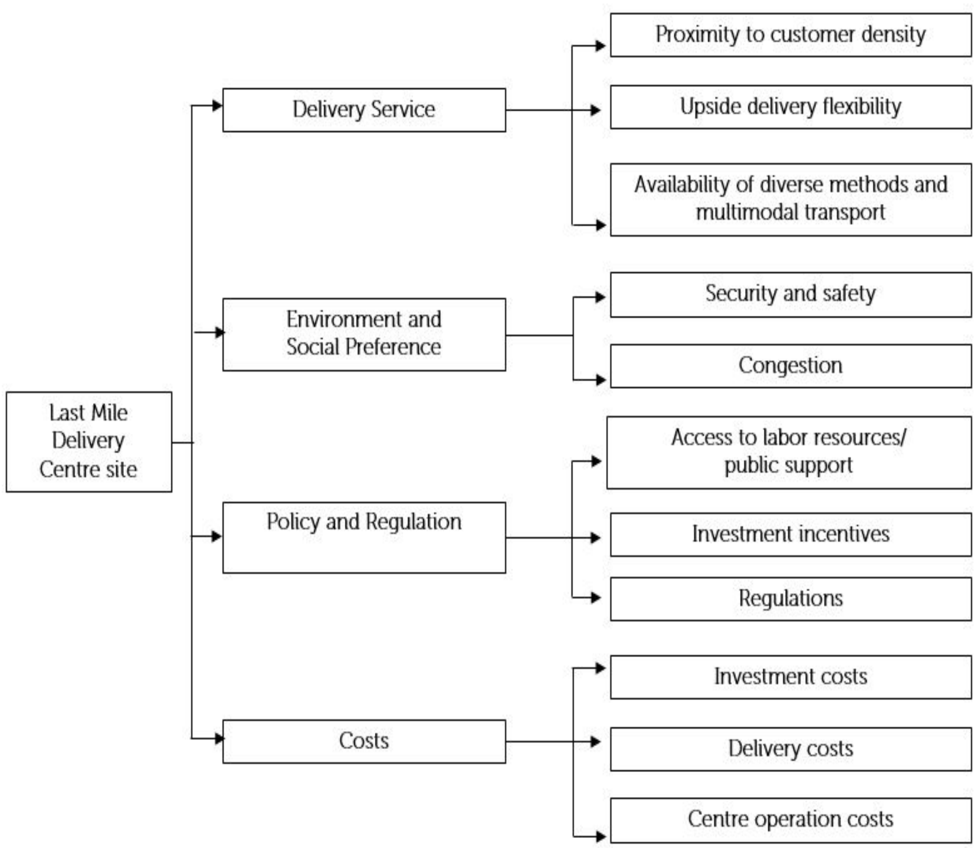
Factors	Sub-factors	The reason why these factors are included
Delivery Service	Proximity to customer density	LMDCs supports covering short distances.
	Upside delivery flexibility	LMDCs deals with demand and time uncertainty and congestion conditions.
	Availability of diverse methods and multimodal transport	Differentiation of capacity and distance of diverse methods in last mile delivery.
Environment and Social Preference	Security and safety	Last mile delivery must be concerned with package protection and safety service in cities.
	Congestion	For avoiding a vehicle in cities.
Policy and Regulation	Access to labour resources/public support	For making workflow processes in LMDCs.
	Investment incentives	For motivating stakeholders to build LMDCs by providing zones that are green zones, tax-free.
	Regulations	For following transport regulation, government policy.
Costs	Investment costs	For investing in new LMDCs/ -renting areas in each location.
	Delivery costs	For comparing each suitable location.
	Centre operation costs	For operating in each LMDCs location.

We collected criterion factors and weighted scores from experts in the parcel delivery industry, and used the Expert Choice software to analyse each criterion's weight and priority in <Table 4> and <Table 5>. The parcel delivery experts hail from both private companies and public authorities, with more than five years' experience in the parcel delivery industry and specializations in distribution and consolidation centres.

The AHP analysis respondents include three from private logistics companies in Thailand and one from Thai public logistics authority. The private companies include local branches of global logistics companies with e-commerce service, global forwarding, freight, and supply chain management. These private logistics companies cover 99.9 % of demands from customers in Thailand.

<Table 4> Composite priorities of factors

Criteria	Delivery Service	Environment and Social Preferences	Policy and Regulations	Costs
Delivery Service	1	7	9	7
		9	9	7
		7	7	1
		9	9	7
Environment and Social Preferences	1/7	1	1/7	1/9
	1/9		3	7
	1/7		1/5	1/5
	1/9		5	1/5
Policy and Regulations	1/9	7	1	1/9
	1/9	1/3		1/7
	1/7	5		1
	1/9	1/5		1/9
Costs	1/7	9	9	1
	1/7	1/7	7	
	1	5	1	
	1/7	5	9	



<Figure 2> Hierarchical representation of LMDC location factors

<Table 5> Overall ratings for criteria framework

Factors	Weight	Sub-Factors	Weight	Priority Weight	Priority Ranking
Delivery Service	0.655	Proximity to customer density	0.508	0.333	1
		Upside delivery flexibility	0.405	0.265	2
		Availability of diverse methods and multimodal transports	0.087	0.057	5
Environment and Social Preferences	0.075	Security and safety	0.648	0.049	6
		Congestion	0.352	0.026	8
Policy and Regulations	0.063	Access to labour resources/ public support	0.363	0.023	10
		Investment incentives	0.243	0.015	11
		Regulations	0.395	0.025	9
Costs	0.207	Investment costs	0.291	0.060	4
		Delivery costs	0.544	0.113	3
		Centre operation costs	0.165	0.034	7

Their duties involve improving freight efficiency in last mile delivery and distribution to the final customer. They work in global companies and distribute domestic parcels that pertain to the growing e-commerce trend. The companies' strategies compete to serve customers' demands on time and generation satisfaction for the end customer. Moreover, the public authority is the largest transporter in Thailand, with services that include an express service, Logispost, Logispost Plus, and One Price Box. Therefore, the experts' experience guarantees pairwise criteria in this study and these experts are likely to understand last mile delivery characteristics.

The delivery service is a priority factor to consider when choosing an LMDC location, as well as cost, environment and social preferences, policy and regulations. Furthermore, regarding sub-factors, proximity to customer density, upside delivery of diverse methods and multimodal transports, and delivery costs are highly ranked.

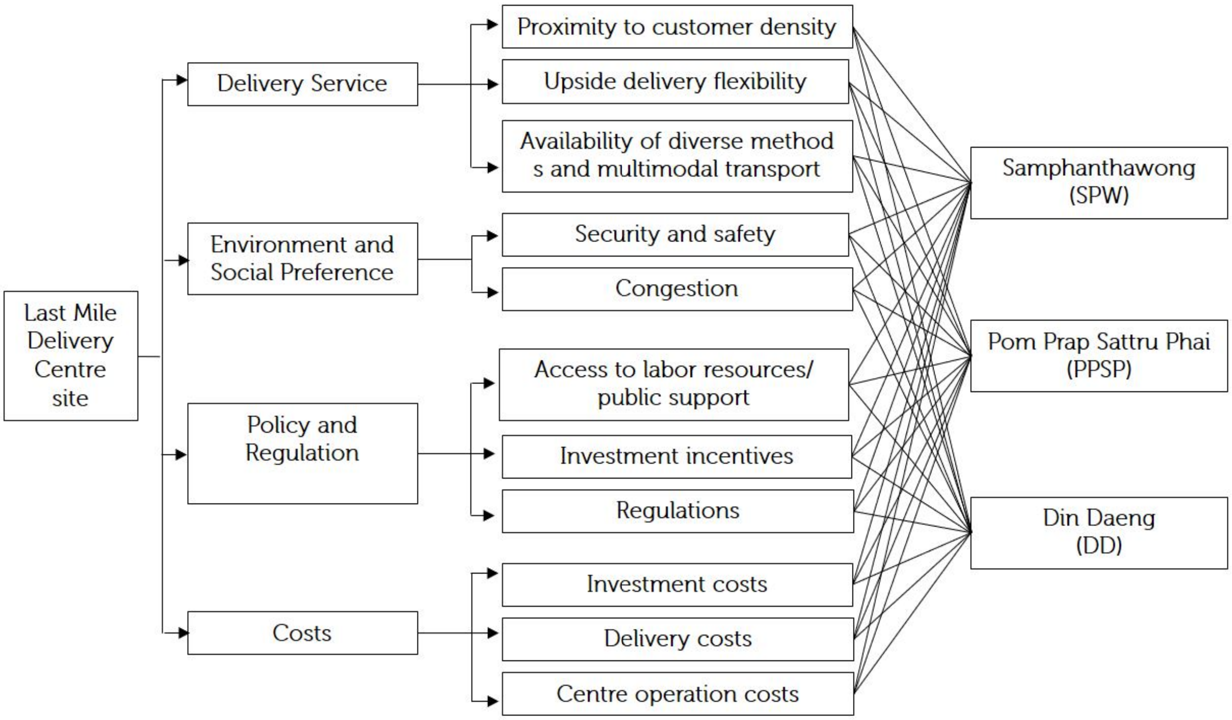
It means LMDC is a logistics centre to improve the efficiency of the activities of the last mile service between UCCs and customers in a short distance for dispatching and covering demand in dense areas. We applied this criteria framework to a case study in Bangkok for helping parcel company select a location of an LMDC.

4. Illustrative Example: A Case Study of Bangkok, Thailand

Approximately 200 million people in East Asia have moved from rural to urban areas with cities' rapid development in East Asia(THE WORLD BANK, 2015). Moreover, Bangkok's population has expanded, increasingly by 2.4 percent since 2010, due to the job and educational opportunities. As Bangkok's area is limited, this has led to congestion, areas of population density, and pollution problems. In addition, Thailand has been ranked fourth in the Asian e-commerce market, behind Singapore, Indonesia, and Malaysia, and Thailand's online retail commerce is expected to grow by at least 30% over the next few years. Olsen et al.(2015) indicated that Thailand's e-commerce market has increased from 60 to 80 percent. Since, the limitation in Bangkok area and growing up in e-commerce, parcel delivery companies in Bangkok have created a strategy for distributing goods to end customers as quickly as possible. However, they always face traffic congestion, which acts as a barrier to travel service times and provides inefficient last mile delivery.

The competition among delivery businesses has dramatically increased, with, parcel delivery companies adapting their businesses to create beneficial customer service by discovering solutions to avoid traffic congestion while reducing the city's pollution. Therefore, companies are focusing on creating values of customer services and market competitiveness. For instance, Kerry Express provided a parcel counter service(customer-to-customer, or C2C) in 2013 by opening a local community parcel shop, with the service using Bangkok's sky train station. Moreover, Kerry Express opened the first parcel shop in Asoke Tower to cover communities in Bangkok. The Thailand post office and DHL also play significant roles in delivering parcels to their customers by avoiding congestion in the city, such as using parcel lockers.

Further, parcel delivery companies are concerned with Bangkok's pollution situation and increasing traffic congestion by responding to the government's truck restrictions. An efficient solution to delivering parcels in the city involves positioning an LMDC in a dense area to cover the community's radius in Bangkok. Thus, LMDCs can improve last mile delivery efficiency from UCCs and dispatch deliveries to their final high-density destinations. However, Thailand lacks research on last mile deliveries and LMDCs.



<Figure 3> Hierarchical representation of LMDC location factor in Bangkok

<Table 6> Priority ranking of alternative solutions for positioning an LMDC in Bangkok, Thailand

Factors	Weight	Sub-Factors	Weight	PPSP	SPW	DD
Delivery Service	0.655	Proximity to customer density	0.508	0.687	0.203	0.111
		Upside delivery flexibility	0.405	0.179	0.373	0.448
		Availability of diverse methods and multimodal transports	0.087	0.275	0.362	0.362
Environmental and Social Preferences	0.075	Security and safety	0.648	0.364	0.303	0.332
		Congestion	0.352	0.582	0.223	0.195
Policy and Regulations	0.063	Access to labour resources/ public support	0.363	0.333	0.333	0.333
		Investment incentives	0.243	0.333	0.333	0.333
		Regulations	0.395	0.495	0.276	0.229
Costs	0.207	Investment costs	0.291	0.629	0.202	0.168
		Delivery costs	0.544	0.397	0.302	0.302
		Centre operation costs	0.165	0.397	0.302	0.302
				0.446	0.284	0.270

Therefore, this study has applied the proper criteria to position an LMDC in Bangkok by ranking priority districts that can increase efficiency in transshipment to a final destination. In this case study, we illustrate the districts that ranked in three dense zones: Pom Prap Sattru Phai(PPSP), Samphanthawong(SPW), and Din Daeng(DD) are in the middle of Bangkok and face high population density and traffic congestion(National Statistical Office, 2015). These three districts in Bangkok are characterized by high population density due to the amount of population per area. To help parcel delivery companies to plan where to locate LMDCs in Bangkok, the criteria framework of LMDC location preference is an important factor for a decision maker in order to solve this situation as <Figure 3> illustrates. Therefore, we applied an AHP methodology to prioritize the candidate district by running processes through Expert Choice software as <Table 6>.

These results of a case study indicate that PPSP is a priority district to invest an LMDC in because it scored the highest, with 0.446, followed by SPW and DD, respectively as <Table 7>. PPSP is in the middle of Bangkok and has a high population density and congestion. So, an LMDC will be in PPP to support the effectiveness of the last mile delivery service. The analysis of this case study depends on the special characteristic of each country. Thailand is a developing country with currently increasing growth in e-commerce; thus, the parcel delivery industry more highly prioritizes its delivery services over environmental and social preferences, which differ from those in developed countries. A method of supplying customers' demands in Thailand's parcel business is more important than pollution concerns. For instance, if a parcel delivery company were offered a choice between a bicycle and motorcycle, it would most likely choose the motorcycle to provide last mile deliveries to its end customers. Cost is ranked as second, followed by environmental and social preferences, and regulation policy.

<Table 7> Priority weight of the alternatives

	PPSP	SPW	DD
Final Scores	0.446	0.284	0.270

5. Discussion and Conclusions

As cities are expanded and crowded. environmental and pollution problems, such as air and noise pollution, traffic congestion, and CO_2 emissions has also increased. Moreover, e-commerce becomes more popular and customers wants faster delivery of their online orders. Thus, traffic congestion and emission policies in cities is a barrier to a customer's last mile delivery in dense areas. Many researchers are looking at improving the efficiency of "last mile" delivery for faster and environmentally safer online order fulfillment. To facilitate this urban logistics system, urban consolidation and last mile delivery concepts have been proposed and tested in many cities.

In this paper, we develop an AHP-based decision making framework to analyse locational preferences for LMDC in urban logistics network to support online order fulfillment. Factors for LMDC location have been proposed based on the references and these factors are prioritized by experts in logistics industry, especially those in Thailand express delivery companies.

The AHP analysis shows that the delivery service factor including proximity to customer and upside delivery flexibility is the most important factor to determine the location of LMDC in urban areas. Since the concept of LMDC has been developed to support faster and safer delivery of online orders, the delivery service factor has been selected as a key driver for network design. In addition, delivery and investment cost factors are selected as the second most important factor for locational decision. Environment and policy factors are evaluated as the least important factors when designing an urban logistics network with LMDC concept. Based on the priorities from the AHP analysis, we applied the result to find proper locations of LMDCs in Bangkok.

Even though the proposed AHP analysis and case study in Bangkok give insights for the locational decision of urban logistics network for faster online order delivery, it has geographical limitations due to the restricted pool of experts participated in the analysis. All the respondents for the AHP analysis come from express delivery companies in Thailand, which implies that the result given in this paper need to be analysed with more experts with diverse industry experiences and nationalities. It would be an interesting research to compare analysis results between countries as well.

In addition, it would be necessary to devise an optimization methodology to find exact locations of LMDC. The proposed AHP analysis gives a high-level guideline for designing urban logistics systems with fast online order fulfillments. An optimization-based approach can help design the exact structure of order fulfillment network with UCC and LMDC.

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